The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 4, Issue 5, 2026

COMPARISON OF COMPUTED TOMOGRAPHY FEATURES OF PULMONARY TUBERCULOSIS IN SMOKERS VERSUS NON-SMOKERS

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DOI: https://doi.org/10.5281/zenodo.20066183

Keywords
Tuberculosis, Cavitation, Nodules, Fibrosis, Smoker, Non-Smoker, Computed Tomography.

Article History
Received: 12 March 2026
Accepted: 22 April 2026
Published: 07 May 2026

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Abstract

Background:
Tuberculosis is an ailment that may result from bacteria. Tuberculosis is viewed as a chronic illness; however, diseases that result from mycobacterium tuberculosis concentrate on the lungs. The disease can stay latent before developing into an ailment, which may easily spread through air droplets that harbor the bacteria. If the level of poverty in any nation is high, the illness continues to pose a major public health challenge, especially in instances of pulmonary tuberculosis.

Objective:
To assess how smoking affects clinical features, radiological severity, and treatment outcomes in pulmonary tuberculosis.

Methodology:
Cross sectional Analytical study was conducted at DHQ Hospital Layyah for four months, to evaluate imaging techniques for detecting the features of tuberculosis in smoker and non-smoker. A total of 73 patients underwent scans using a computed tomography (128 slice Toshiba), with all observations recorded by radiologists. Data analysis was performed using SPSS 27.0 to determine distribution, frequency, percentage, and diagnostic accuracy.

Results: *This study consists of 73 patients having pulmonary tuberculosis with features of cavitation, nodules and fibrosis. The main purpose of this study was to assess how smoking affects clinical features, radiological severity, and treatment outcomes in pulmonary tuberculosis. As a result, this study showed a significant relationship between smoking and nodules in tuberculosis patients. By using Chi-square testing ($p = 0.002$), all showed consistent relationship that nodules increase with severity of smoking in tuberculosis patients on Computed Tomography. On other hand there is no significant relationship detected among features of tb such as cavitation and fibrosis in smoker and non-smoker. Chi-square analysis ($p = 0.17$, $p=0.13$) are not according to their significant value respectively.*

Conclusion: *It is concluded that smoking greatly effects the feature of tuberculosis. Smoking is correlated with nodules, the feature of tuberculosis. Nodules are much more in smoker as compare to non-smoker.*

INTRODUCTION

Tuberculosis is a chronic infectious disease caused by Mycobacterium tuberculosis, primarily affecting the lungs but capable of

involving almost any organ in the body. It is transmitted through airborne droplets from individuals with active pulmonary disease. The infection may remain latent for years or progress to active disease, characterized by chronic cough, fever, weight loss, and night sweats [1]. PTB is particularly prevalent in poor nations, where it poses an ecological threat and claims the lives of roughly a million people annually. One terrible illness that can have a severe effect on its sufferers is pulmonary TB. Mycobacterium tuberculosis is the bacterium that causes tuberculosis, a dangerous respiratory infection. Although the lungs are frequently affected, other bodily components like the kidney, spine, and brain may also be impacted. Approximately one-third of the world's population is infected with the bacteria, meaning that the global burden of tuberculosis is still significant[2].Pulmonary tuberculosis is recently one of the leading causes of death due to infectious diseases in the whole world. It is a highly infectious condition caused by *Mycobacterium tuberculosis*. Currently global reports indicated that in 2018, nearly 7 million new and relapse cases of TB were officially identified, with the total estimated number of cases reaching about 10 million. Among those patients, approximately 900,000 were also infected with Human immunodeficiency virus. In the same year, TB concluded in about 1.5 million deaths globally, including around 251,000 deaths among HIV-positive individuals.[3]

Pulmonary tuberculosis is commonly in people with normal immunity, with the lungs affected in about 79% to 87% of cases. Same rates of lung involvement are also noticed in immunocompromised individuals, especially those with human immunodeficiency virus infection, where studies from the 1980s and 1990s shoed involvement in 70% to 92% of patients. However, immunocompromised patients are more likely to induce tuberculosis outside the lungs compared to immunocompetent individuals.[4]Pulmonary tuberculosis commonly presents with symptoms such as fever, night sweats, unusual fatigue, persistent cough, and hemoptysis. In non-immunocompromised adults, the disease typically follows a slow and gradual course. In contrast, children and immunocompromised individuals may develop a more aggressive form of tuberculosis with rapid onset. Tuberculosis should be considered in any patient who has a cough lasting longer than three weeks.[5]

The major risk factors for TB include low socioeconomic status, malnutrition, overcrowding, HIV infection, diabetes mellitus, substance abuse, and smoking. Immunosuppressed individuals, such as those with HIV/AIDS or on long-term corticosteroid therapy, are at particularly high risk of developing active disease. Other associated factors include alcoholism, exposure to unpasteurized milk, prior incarceration, and poor living conditions, all of which facilitate transmission [6].

Tobacco smoking has emerged as a significant modifiable risk factor. It impairs mucociliary clearance, alters alveolar macrophage function, and reduces local immune response, thereby increasing both susceptibility to infection and risk of progression from latent to active TB. A positive dose–response relationship between smoking intensity and TB risk has been documented [7]. As tobacco smoke affects mucociliary clearance and reduce immunological responses in the lungs, smoking is a great risk factor for pulmonary tuberculosis. Between Smokers and Non-Smokers, smokers are much more to contract Mycobacterium tuberculosis, produce active pulmonary illness, and have poorer treatment results. The longer and more intense smoking increases the likelihood of developing tuberculosis, which develops more severe lung involvement and a greater death rate.[8]

Close contact with infectious cases, crowded and poorly ventilated housing circumstances, low socioeconomic level, malnutrition, and co-occurring diseases including HIV infection and diabetes mellitus are major risk factors for pulmonary tuberculosis in nonsmokers. These elements weaken host immunity or raise exposure to Mycobacterium tuberculosis, indicating that pulmonary tuberculosis is still a serious health risk even when tobacco smoke exposure is not present.[9]

Despite of good treatment, tuberculosis is still a major source of human suffering and death. Timely and accurate diagnosis is still an unfulfilled objective. The HIV pandemic has

also made diagnosing tuberculosis more difficult. The worldwide effort to combat tuberculosis may benefit from a number of recent advancements in TB testing. Our goal is to examine the effectiveness of both novel and current diagnostics for adult pulmonary tuberculosis and talk about the ongoing difficulties.[10]

Tuberculosis shows a clear gender disparity worldwide, with men being disproportionately affected compared to women. Globally, adult men are about 1.5 to 2 times more likely to develop TB than women, both in terms of disease incidence and mortality. Several biological, behavioral, and social factors contribute to this difference. Men are more likely to have higher exposure due to occupational and social factors, delayed healthcare-seeking behavior, and a higher prevalence of risk factors such as tobacco smoking, alcohol consumption, and occupational dust exposure.[11] Computed Tomography of the chest plays a crucial role in the diagnosis, evaluation, and follow-up of pulmonary tuberculosis. While chest X-ray remains the initial imaging modality, CT provides superior sensitivity and specificity in detecting parenchymal and airway abnormalities. It offers high-resolution, cross-sectional imaging that allows detailed visualization of lung architecture and the distribution of lesions, helping differentiate active from inactive disease. [12] A CT scan of active postprimary pulmonary tuberculosis typically shows lobular consolidation, cavitation, thickening of the bronchial wall, centrilobular nodules, and branching linear structures (tree-in-bud look). Inactive pulmonary tuberculosis can be detected by CT with parenchymal bands, irregular linear opacity, calcified nodules or consolidation, and pericicatricial emphysema. On CT scans, primary tuberculosis usually shows up as homogenous, dense, well-defined segmental or lobar consolidation with elevated lymph nodes in the mediastinum or hilum. Primary and postprimary TB can also cause miliary nodules. CT shows tuberculomas as a nodule with internal cavitation and satellite nodules surrounding it.[13]

Effective treatment of tuberculosis (TB) requires early detection. While computed tomography (CT) is more sensitive in identifying lymphadenopathy, chest radiography is still the gold standard for diagnosing parenchymal illness in primary pulmonary TB. CT is the preferred technique for identifying early bronchogenic spread in post-primary pulmonary tuberculosis. CT is more sensitive than radiography when it comes to determining whether and infection is active or not.[14]Imaging plays a very important role in the finding of pulmonary tuberculosis. Computed tomography is more advanced than chest X-rays in diagnosing small, solid TB lesions. However, only a limited number of studies have compared CT findings between AFB-positive and AFB-negative PTB cases. This study aims to evaluate the clinical characteristics and CT features of AFB-positive and AFB-negative PTB in hospitalized adult patients, considering the significant societal burden associated with tuberculosis.[15]

Pulmonary tuberculosis is a major global health concern, with CT imaging playing important role in its diagnosis. Smoking changes lung immunity and architecture, which may change the CT appearance of TB, causing atypical or more extensive disease patterns. Understanding these differences between smokers and non-smokers can increase diagnostic accuracy and optimize patient management. Therefore, limited studies have compared CT features of pulmonary TB between smokers and non-smokers, especially in our population. This study aims to fill this gap by knowing distinctive radiological patterns related with smoking in TB patients.

OBJECTIVES

To assess how smoking affects clinical features, radiological severity, and treatment outcomes in pulmonary tuberculosis.

METHODOLOGY

The research utilized a cross-sectional analysis approach carried out at DHQ Hospital Layyah over a period of four months. 73 patients were selected using convenient sampling approach on the basis of a 95% confidence level and 5% margin of error. Male and female patients aged 18-65 years who have been diagnosed with pulmonary tuberculosis, both smokers and non-smokers, were part of the study. Patients with

extra-pulmonary TB, pregnant women, lung impairment, and incomplete record were excluded from the study. Demographics, symptoms, and history of smoking were gathered through structured proforma. All patients were subjected to High Resolution Computed Tomography scanning following established protocols, including thin-section scanning of the chest. Features like cavitations, nodules, and fibrosis were examined by radiologists who were not aware of smoking status. Ethical permission was taken, and consent was taken from each participant. Confidentiality and rights of participants were strictly respected. Data was entered in the software of SPSS 27 for analysis. Frequency, mean, and percentage were calculated under descriptive statistics. Difference between two parameters was evaluated by t-test and chi-square.

RESULTS

This study consists of 73 patients having pulmonary tuberculosis with features of cavitation, nodules and fibrosis. The main purpose of this study was to assess how smoking affects clinical features, radiological severity, and treatment outcomes in pulmonary tuberculosis. As a result, this study showed a significant relationship between smoking and nodules in tuberculosis patients. By using Chi-square testing (p = 0.002), all showed consistent relationship that nodules increase with severity of smoking in tuberculosis patients on Computed Tomography. On other hand there is no significant relationship detected among features of tb such as cavitation and fibrosis in smoker and non-smoker. Chi-square analysis (p = 0.17, p=0.13) are not according to their significant value respectively. Overall, in patients with smoking, nodules generally seem to be a major radiographic indicator associated with tb, although cavitation and fibrosis severity does not show a significant prognostic value.

Table 4.1 Table of Gender Distribution

Gender		Frequency	Percent	Cumulative Percent
	Female	35	47.9	47.9
	Male	38	52.1	100.0
	Total	73	100.0	

This table shows the gender distribution of the sample population, with females (35) accounting for 47.9% and males (38) for 52.1%, for a total of 73 participants. The cumulative percentage of both genders is 100%.

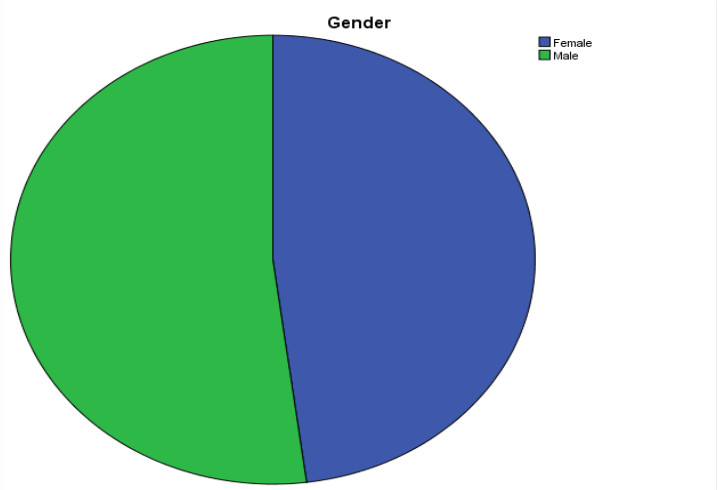
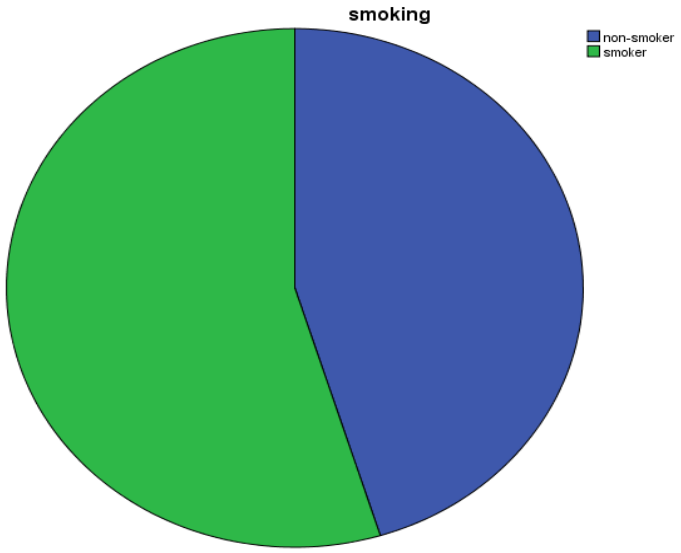


Figure # 4.1 This figure describes the gender breakdown of a sample population, indicating 47.9% females and 52.1% males. The male group has a slightly higher frequency than the female group.

Table 4.2 Frequency Table of Non-Smoker and Smoker

		Frequency	Percent	Valid Percent	Cumulative Percent
	non-smoker	33	45.2	45.2	45.2
	smoker	40	54.8	54.8	100.0
	Total	73	100.0	100.0	

According to Table 4.2, among the 73 patients assessed, 33 were non-smoker, while 40 patients were smoker.

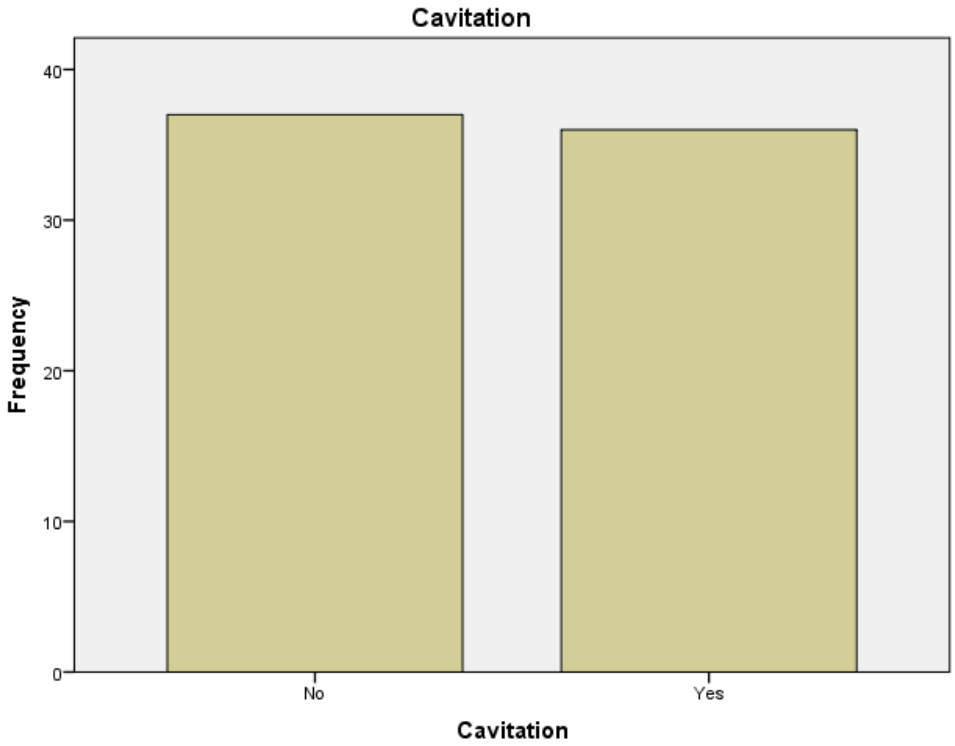


According to Figure 4.2, among the 60 patients assessed, 10 exhibited normal spleen size, while 23 patients showed mild splenomegaly,20 showed moderate splenomegaly, and 7 demonstrated severe splenomegaly.

Table 4.3 Frequency Distribution of Cavitation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	37	50.7	50.7	50.7
	Yes	36	49.3	49.3	100.0
	Total	73	100.0	100.0	

Regarding table 4.3, there were 73 patients noticed ,36 showed cavitation , while 37 presented with no cavitations of tuberculosis.



According to Figure 4.3, there were 73 patients noticed ,36 showed cavitation, while 37 presented with no cavitations of tuberculosis.

Table 4.4 Frequency Distribution of Nodules

Nodules		Frequency	Percent
	no	9	12.3
	yes	64	87.7
	Total	73	100.0

In relation to Table 4.4, the total number of patients in the population sample is 73. Out of which, 64 patients were found to have nodular lesions caused by tuberculosis, whereas 9 did not show any signs nodules.

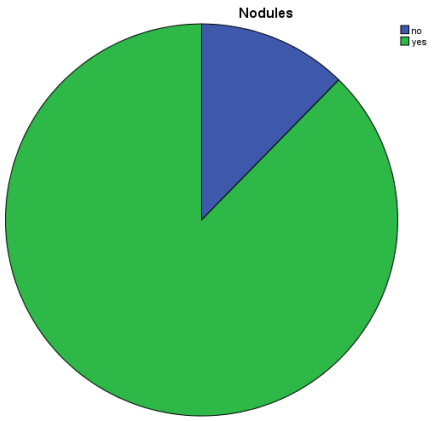


Figure 4.4 illustrates the total number of patients in the population sample is 73. Out of which, 64 patients were found to have nodular lesions caused by tuberculosis, whereas 9 did not show any signs of nodules.

Table 4.5 Frequency Distribution of Fibrosis:

Fibrosis		Frequency	Percent
	no	26	35.6
	yes	47	64.4
	Total	73	100.0

Table 4.5 shows the total number of patients in the population sample is 73. Out of which, 47 patients were found to have fibrotic lesion lesions caused by tuberculosis, whereas 26 did not show any signs of fibrosis.

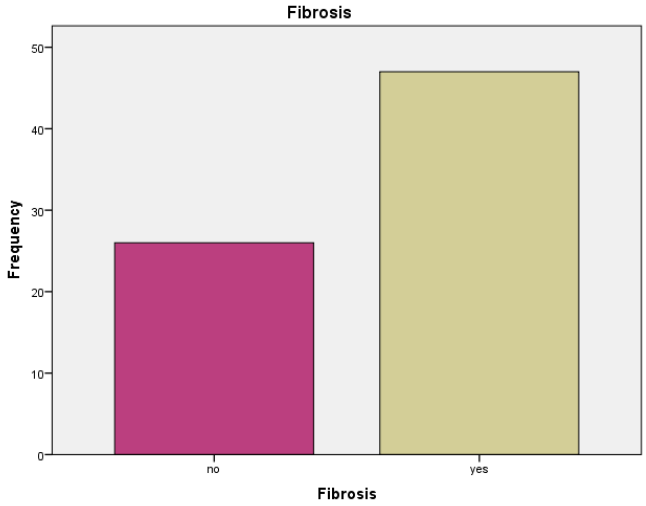


Figure 4.5: Frequency Distribution of Fibrosis

Table 4.5 shows the total number of patients in the population sample is 73. Out of which, 47 patients were found to have fibrotic lesion lesions caused by tuberculosis, whereas 26 did not show any signs of fibrosis.

Table 4.6 Gender And smoking Crosstabulation

Gender * smoking Crosstabulation				
		smoking		Total
		non-smoker	smoker	
Gender	Female	30	5	35
	Male	3	35	38
Total		33	40	73

Table 4.6 shows a crosstab of gender and smoking. Among 73 patients, there was total 35 females, out of which 30 were non smoker and 5 were smoker and 38 males, among them, 3 were nonsmoker, 35 were smoker.

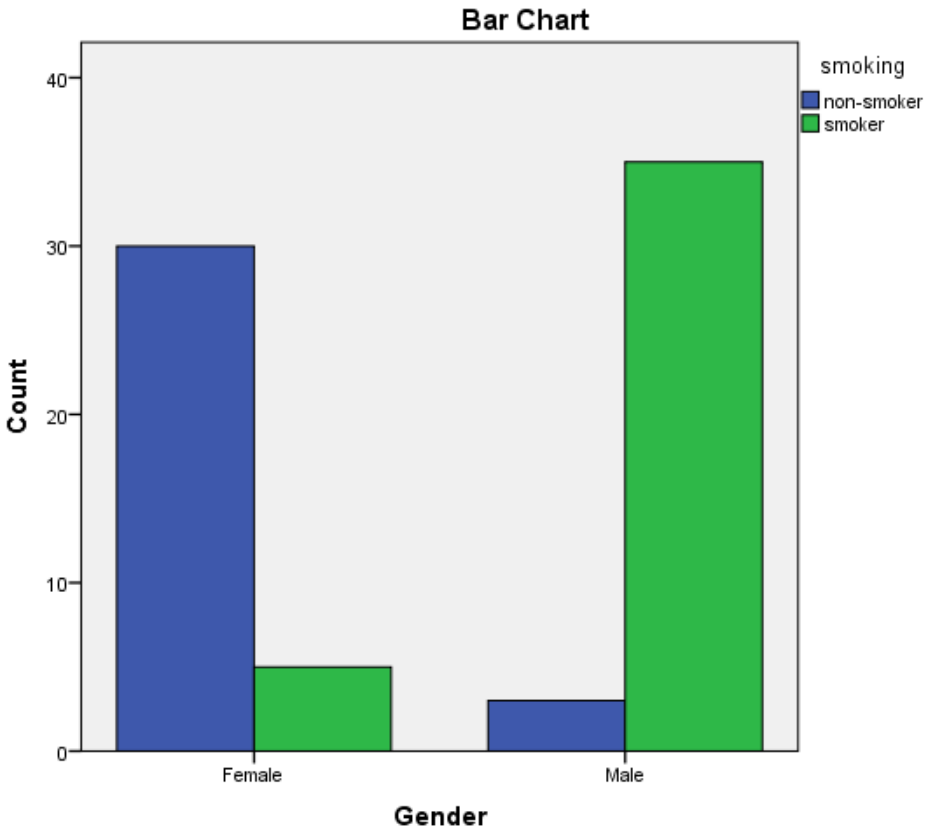


Figure 4.6 shows a crosstab of gender and smoking. Among 73 patients, there was total 35 females, out of which 30 were non-smoker and 5 were smoker and 38 males, among them, 3 were nonsmoker, 35 were smoker.

Table 4.7 Correlation of Smoking and Cavitation

Smoking * Cavitation Crosstabulation				
Count				
		Cavitation		Total
		No	Yes	
smoking	non-smoker	17	16	33
	smoker	20	20	40
Total		37	36	73

Table 4.7 shows that Cross-tabulation of smoking and cavitation indicates that there is a total of 73 individuals under study. Out of these individuals, 33 are non-smokers and 40 are smokers. Out of 33 non-smokers, 17 are found not to have cavitation, whereas, among 40 smokers, 20 were found to have cavitation and 20 did not have cavitation. Overall, there were 36 cases of cavitation and 37 cases without cavitation.

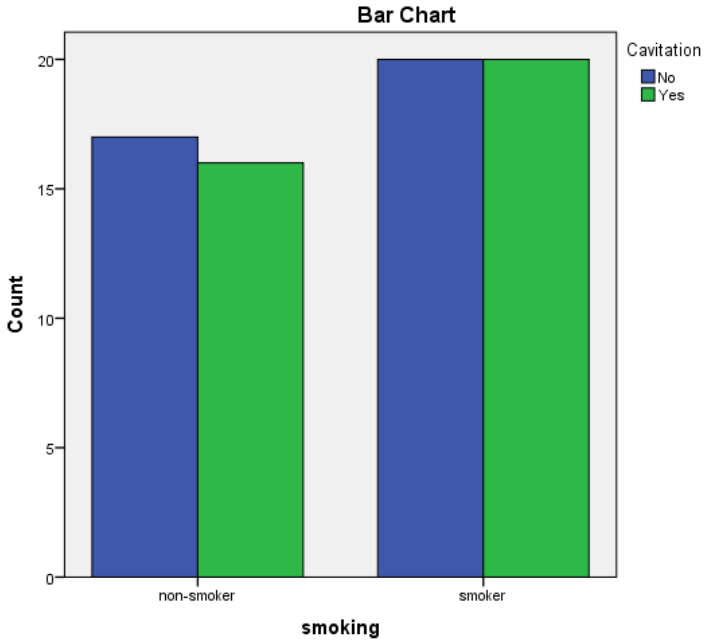


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Table 4.8: Chi-Square Test of Smoking and Cavitation

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.017[a]	1	.897
Likelihood Ratio	.017	1	.897
Linear-by-Linear Association	.016	1	.898
N of Valid Cases	73		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 16.27.
b. Computed only for a 2x2 table

Table 4.8 shows that there was no significant relationship among the factors, based on the findings from the Pearson Chi-Square test (χ^2 = 0.017, df = 1, p = 0.897). In addition, non-significant outcomes were reported through the Likelihood Ratio and Linear-by-Linear Association tests (p = 0.897 and p = 0.898, respectively). The validity of the test results was validated by this study, since the study used 73 valid cases, and all expected counts were adequate (expected count minimum = 16.27).

Table 4.9 Correlation of Smoking and Nodules:

Smoking And Nodules Crosstabulation				
Count				
		Nodules		Total
		no	yes	
smoking	non-smoker	3	30	33
	smoker	6	34	40
Total		9	64	73

Table 4.9 shows that Cross-tabulation of smoking and Nodules indicates that there is a total of 73 individuals under study. Out of these individuals, 33 are non-smokers and 40 are smokers. Out of 33 non-smokers, 3 are found not to have nodules, whereas, among 40 smokers, 34 were found to have cavitation and 6 did not have cavitation. Overall, there were 64 cases of cavitation and 9 cases without cavitation.

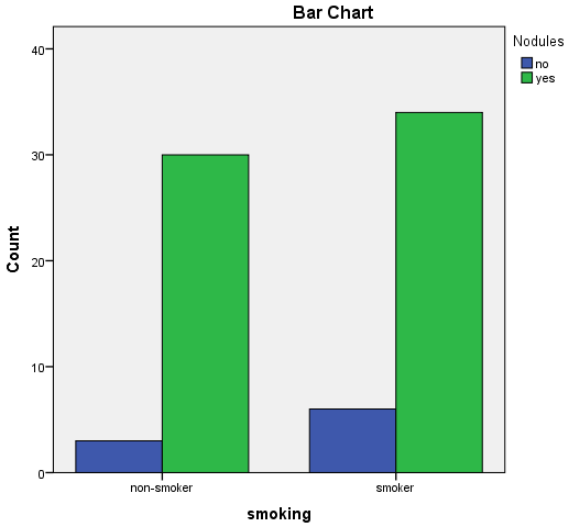

Figure 4.8: Crosstab of Smoking and Nodules

Table 4.10: Chi-Square Test of Smoking and Nodules:

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.002[a]	1	.034
Likelihood Ratio	.027	1	.040
Linear-by-Linear Association	.046	1	.048
N of Valid Cases	73		

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.07.
b. Computed only for a 2x2 table

The relationship between the smoking and nodules is statistically significant, as per the results of the Chi-square test. The significance is evident from the results of the Pearson Chi-Square test (χ^2= 0.002, df = 1, p-value = 0.034). Moreover, at the 0.05 level of significance, the results of the Likelihood Ratio (p-value = 0.040) and the Linear-by-Linear Association (p-value = 0.048) are statistically significant.

Table 4.11 Correlation of Smoking and Fibrosis:

Smoking And Fibrosis Crosstabulation				
Count				
		Fibrosis		Total
		no	yes	
smoking	non-smoker	11	22	33
	smoker	15	25	40
Total		26	47	73

Table 4.11 shows that Cross-tabulation of smoking and Fibrosis indicates that there is a total of 73 individuals under study. Out of these individuals, 33 are non-smokers and 40 are smokers. Out of 33 non-smokers, 11 are found not to have fibrosis, whereas, among 40 smokers,

25 were found to have fibrosis and 15 did not have fibrosis. Overall, there were 47 cases of fibrosis and26 cases without fibrosis.

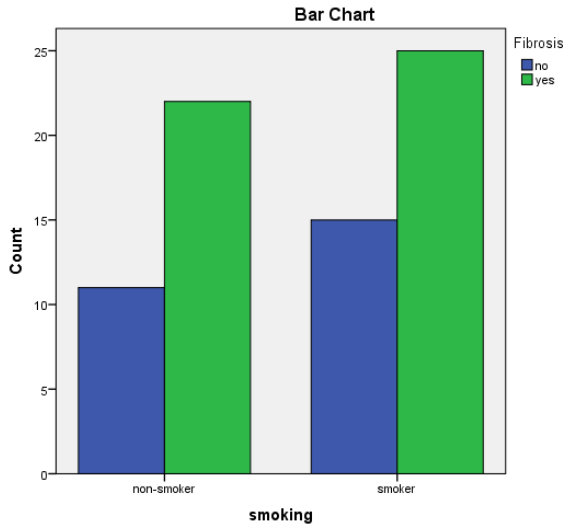

Figure 4.9: Crosstab of Smoking and Fibrosis shows that Cross-tabulation of smoking and Fibrosis indicates that there is a total of 73 individuals under study. Out of these individuals, 33 are non-smokers and 40 are smokers. Out of 33 non-smokers, 11 are found not to have fibrosis, whereas, among 40 smokers, 25 were found to have fibrosis and 15 did not have fibrosis. Overall, there were 47 cases of fibrosis and26 cases without fibrosis.

Table 4.12: Chi-Square Test of Smoking and Fibrosis:

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.137[a]	1	.711
Likelihood Ratio	.137	1	.711
Linear-by-Linear Association	.135	1	.713
N of Valid Cases	73		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.75.
b. Computed only for a 2x2 table

Table 4.12 shows that there was no significant relationship among the factors, based on the findings from the Pearson Chi-Square test (χ^2 = 0.137, df = 1, p = 0.711). In addition, non-significant outcomes were reported through the Likelihood Ratio and Linear-by-Linear Association tests (p = 0.137 and p = 0.711, respectively). The validity of the test results was validated by this study, since the study used 73 valid cases, and all expected counts were adequate (expected count minimum = 11.75).

DISCUSSION

In the current study, 73 patients suffering from pulmonary tuberculosis were included, where the association between smoking and certain radiological parameters like cavitation, nodules, and fibrosis on CT imaging was analyzed. In this study, the key focus was to determine the effect of smoking on the disease severity in clinical and radiological manifestations of tuberculosis.

The results obtained from the current study revealed that there was a strong correlation between smoking and pulmonary nodules (p = 0.002). This means that there is an increased likelihood of observing nodular lesions among smokers. On the other hand, there was no significant correlation between smoking and cavitation (p = 0.897) or fibrosis (p = 0.711).

According to Gajalakshmi et al., smoking is known to cause an increased risk for tuberculosis severity and deaths, and thus smoking becomes one of the critical determinants in disease progression [16]. Also,

Lin et al. showed from their systematic review and meta-analysis that smoking leads to reduced immune function and increased susceptibility to TB, resulting in increased severity of the lung involvement in patients suffering from TB [17]. Moreover, in the study conducted by den Boon et al., it was found that smoking plays a key role in determining susceptibility to tuberculosis infection among high-incidence populations because of which the host defense mechanism is affected [18]. Thus, smokers tend to suffer from radiologic abnormalities. On the contrary, the absence of a strong link between smoking and cavitation or fibrosis in this study implies that these radiographic findings could be related to other variables including the duration of the disease, the body's defense mechanism, and chronic inflammation rather than smoking alone. Cavitation and fibrosis typically reflect severe forms of lung damage, which are not necessarily triggered by cigarette smoking. All in all, the results of this study indicate that smoking is strongly correlated with nodule formation in pulmonary tuberculosis, but there is no statistical association between smoking and either cavitation or fibrosis.

CONCLUSION

The present study found that there is a strong connection between smoking and nodular changes in the lungs among individuals diagnosed with tuberculosis. This suggests that smoking plays an important part in the occurrence of inflammation in the radiological appearance of pulmonary tuberculosis. In contrast, no link was discovered between smoking and advanced pathological changes like cavitary and fibrotic conditions. The research findings suggest that smoking is only related to the early radiological presentation of tuberculosis and not to its chronic forms.

Limitation

In considering the results obtained from this study, it must be noted that there are several factors that may have affected the reliability and applicability of the findings to the population at large. Firstly, because of the small number of subjects used for research (only 73 patients), these results may not be generalized. Second, since the study was conducted at one location, selection bias may have occurred. Third, patient self-reporting of his/her smoking habits may lead to recall bias. Fourth, while other important confounders such as concomitant diseases, duration of disease, exposure, and pack-years of smoking were taken into account, some of them may have still remained uncontrolled. Lastly, the cross-sectional design of the study did not allow to establish any causative relationship between the variables studied.

Recommendations

For future investigations, it is suggested that more people be involved to improve the validity and generalizability of the findings. For a more accurate assessment of the effects of smoking on the severity of the condition, a careful assessment of exposure to smoking, such as pack-years and smoking duration, must be considered. Longitudinal studies are also suggested for the identification of a more robust causal relationship between smoking and the progression of radiological changes in patients with tuberculosis. To reduce the severity of the disease and improve the quality of life of patients, cessation of smoking must also be a priority in treating tuberculosis.

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